Precipitation Products in the GOES-R Proving Ground

Jack Dostalek
Cooperative Institute for Research in the Atmosphere, Colorado State University

Steve Businger (University of Hawaii)
Mark DeMaria, John Knaff (NESDIS/RAMMB)
Michael Folmer (HPC/OPC/SAB)
Stan Kidder, Steve Miller (CIRA/CSU)
Robert J. Kuligowski (NESDIS/STAR)
Tony Wimmers (CIMSS/University of Wisconsin—Madison)

Introduction

- Precipitation is an important component to any forecast

- Surface observations, radiosondes, wind profilers, models, radar, and satellites (polar-orbiting and geostationary – including the upcoming GOES-R) are tools for the forecaster

- Here, the GOES-R Proving Ground precipitation products are reviewed.

Products

- Group 1 (Synoptic Scale)
  - Red-Green-Blue (RGB) Airmass
  - GOES-R Total Precipitable Water (TPW)
  - Atmospheric Rivers Product

- Group 2 (Local Scale)
  - Orographic Rain Index (ORI)
  - Rainfall Potential Algorithm
  - Rainfall Probability Algorithm

➢ The products are in varying states of development.

Group 1
(Synoptic Scale)

RGB Airmass

(Folmer, Knaff)

• Different channel combinations provide the amount of red, green, and blue in the satellite image. MSG example:

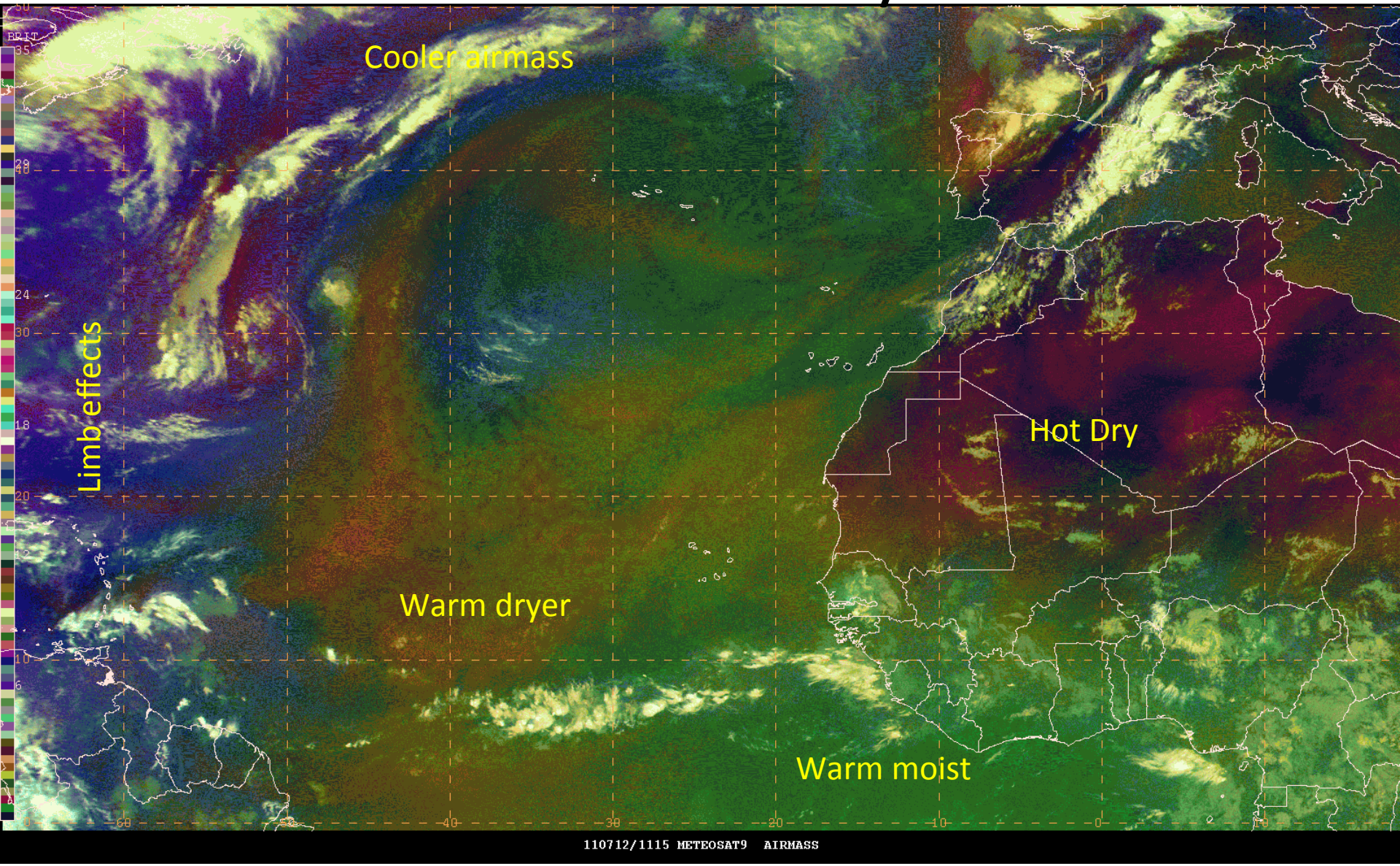
- 6.25µm-7.35µm
- 9.66µm-10.8µm
- 6.25µm

• GOES-R proxy data provided by SEVIRI on MSG or by GOES sounder.

• Shows clouds and different air masses

• Used at NHC and HPC

RGB Airmass – 12 July 2011



GOES-R TPW

(Wimmers)

- Water vapor integrated through depth of atmosphere at high horizontal and temporal resolution – better than raob or surface network

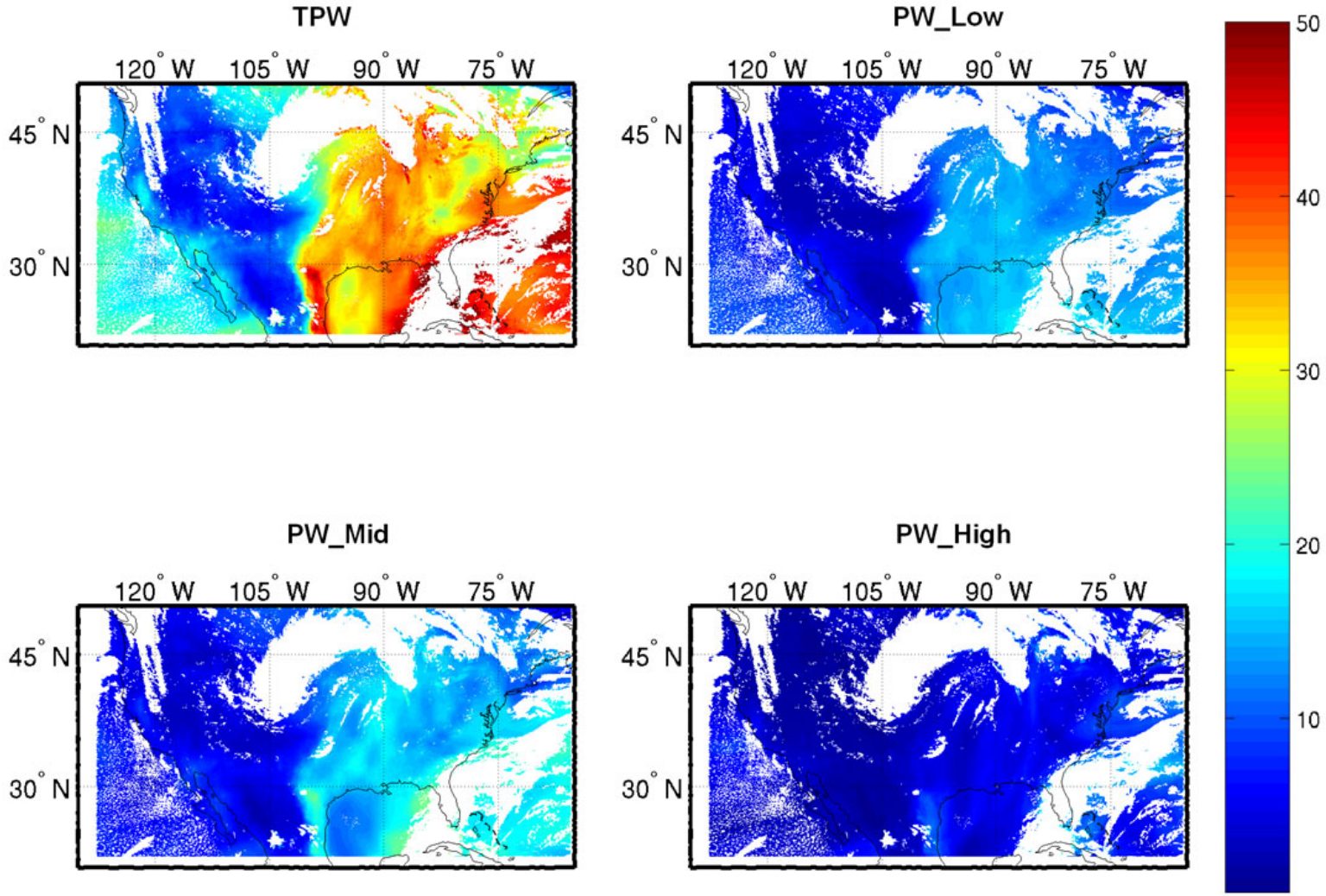
- Examples of use: moisture returning from Gulf of Mexico, drylines, air mass identification

- Infrared product — TPW in clear areas only

- Possible use of Morphed Integrated Imagery at CIMSS - Total Precipitable Water (MIMIC-TPW) for development and validation.

GOES-R TPW

(Simulated GOES-R TPW and constituent data, from GOES-R web page)



Atmospheric Rivers Product

(Businger, DeMaria, Dostalek, Miller)

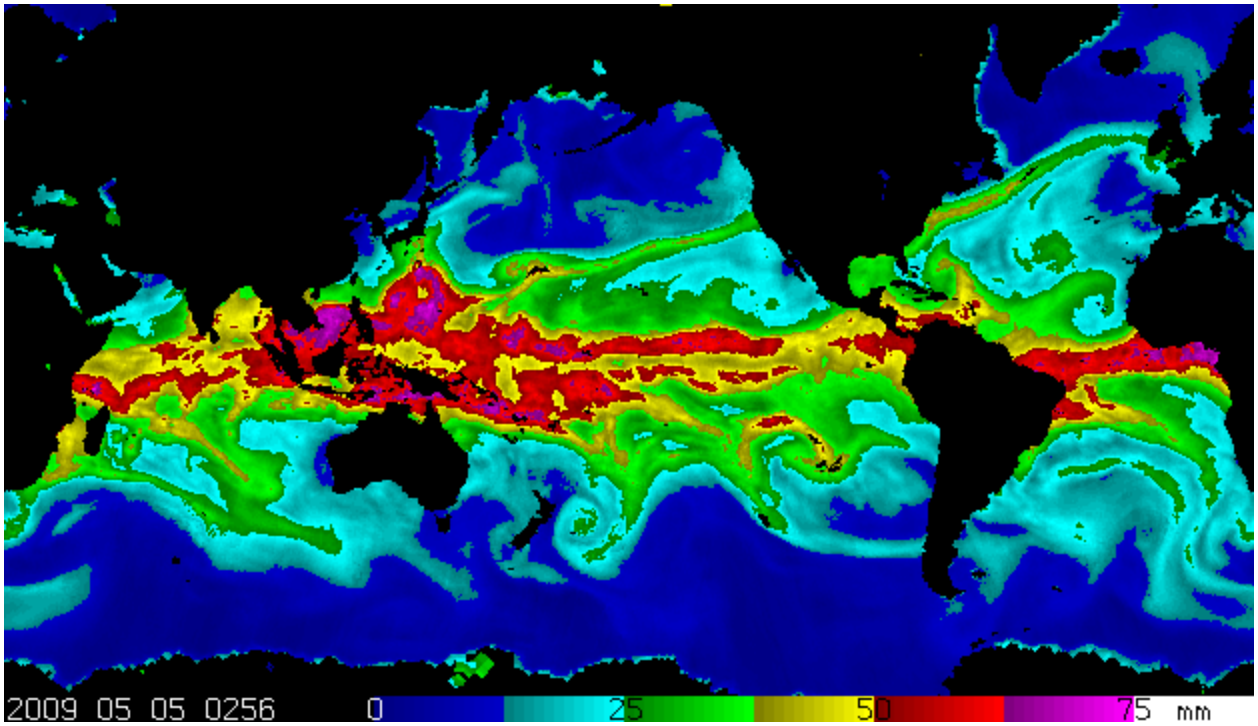
- Atmospheric rivers: Narrow region of large water vapor flux in front of cold fronts, often all the way from Tropics

- Can provide the moisture source for heavy rain along West Coast

- Originate over the ocean, so difficult to observe

- Satellites can help
  - Polar-orbiting: Microwave radiation not appreciably attenuated by clouds, timeliness an issue
  - Geostationary: Good horizontal and temporal resolution, retrievals in clear sky only

Atmospheric Rivers Product



CIRA Blended TPW Product, 5 May 2009

Atmospheric Rivers Product

Thoughts/Ideas:

1) Product based on Orographic Rain Index (to be discussed next)

2) Combined Polar/GOES
   - Polar microwave for TPW
   - GOES for TPW and feature-tracked winds

3) Low –level moisture and winds

Group 2
(Local Scale)

Orographic Rain Index (ORI)

(Kidder, Miller)

- 0-3 hour forecast of the *potential* for heavy orographic rain
- Available on AWIPS via LDM
- Evaluation at NESDIS' Satellite Analysis Branch

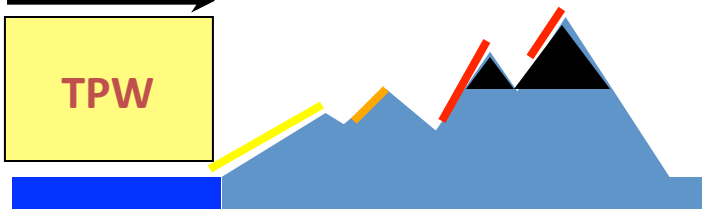
- Inputs
  - CIRA blended TPW (GOES/AMSU/GPS) (TPW)
  - GFS 850-hPa wind ($\mathbf{v}$)
  - USGS 30 arc-second elevation data (H)
- Output
  - $ORI = TPW(\mathbf{V} \bullet \nabla H)$,units kg s^{-1} m^{-1}

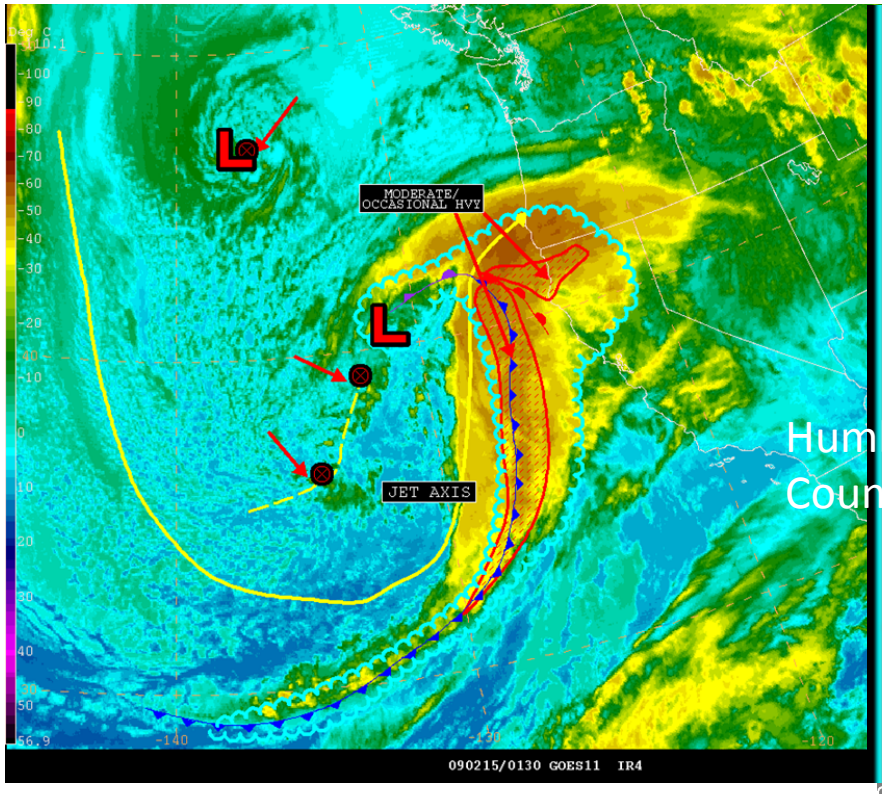
Orographic Rain Index (ORI)

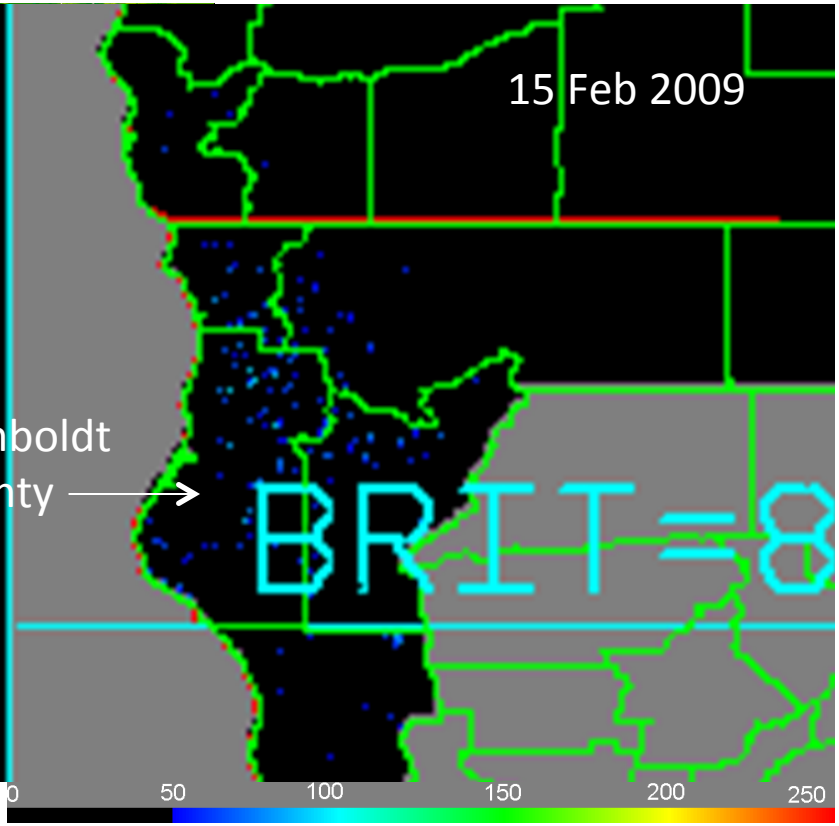
Adapted from slides by Steve Miller, CIRA

V(850mb)

ORI = TPW * **V**•∇H







Orographic Rain Index (ORI)

Courtesy Steve Miller, CIRA

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ZCZC NFDSPENES ALL
SPENES
CAZ000-ORZ000-
.
SATELLITE PRECIPITATION ESTIMATES..DATE/TIME 02/15/09 0152Z
SATELLITE ANALYSIS BRANCH/NESDIS---NPPU---TEL.301-763-8678
LATEST DATA USED: GOES-11 0145Z KUSSELSON
NOAA AMSU:2111Z/2350Z  NASA AMSR-E:2135Z
.
LOCATION...N CALIFORNIA...SW OREGON...
.
ATTN WFOS...MFR...STO...MTR...EKA...
ATTN RFCS...NWRFC...CNRFC...
.
EVENT...OCCLUSION LIFTING NNE AND BEST MOISTURE ADVECTION HEADING
TOWARD
N CA AND SW OREGON...
.
SATELLITE ANALYSIS AND TRENDS...SURFACE AND UPPER LOW SETTLING INTO
40N/131W WITH OCCLUSION LIFTING NNE THE PAST FEW HRS OFFSHORE OR-CA
BORDER COAST NEAR 41N/127.5W.  ENERGY COMING AROUND LOW AND APPROACHING
130W WILL HELP FURTHER DEVELOP A WAVE ON FRONT JUST SOUTH OF OCCLUSION
TO ALLOW FOR SURGE OF MOISTURE AND PRECIP INTO NORTHERN CA SOUTH OF
CAPE MENDOCINO.  BUT FOR FIRST HALF OF THE NIGHT WARM OCCLUSION WILL BE
AFFECTING AREA FROM FAR N MENDOCINO TO TEHAMA NORTH TO OREGON BORDER
AND
BEGINNING TO SEEP MORE INTO SW OREGON AS OCCLUSION LIFTS SLOWLY NORTH.
EXPERIMENTAL OROGRAPHIC PRECIP INDEX SHOWING BEST MOISTURE TRANSPORT
WITH OROGRAPHICS INTO HUMBOLDT COUNTY THRU 03Z WHICH COULD INCLUDE FAR
N CENTRAL AND NW CA COUNTIES IN THE 03-06Z TIME PERIOD...AT SAME TIME
FRONTAL BOUNDARY WITH NARROW MOIST PLUME CONTINUES SHIFTING EAST TO
REST OF THE NORTHERN CA COAST.  OVERLAYING 85H/70H WIND FLOW ON COMMA
SHAPED ATMOSPHERIC RIVER MOISTURE PLUME SHOWS MOISTURE TRANSPORT/
MOISTURE FLUX IMPROVING AND AIMED AT FAR N CA/EX SW OREGON NEXT FEW
HRS...AND WILL LIKELY CONTINUE VERY GOOD THRU MOISTURE PLUME WITH FRONT
AS IT APPROACHES REST OF N CA THIS EVENING AND TONIGHT.
WILL CONTINUE TO MONITOR...ANALYSIS GRAPHIC ON HOME PAGE AT ADDRESS
BELOW...
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Rainfall Potential Algorithm

(Kuligowski)

- Direct measurement of rainfall

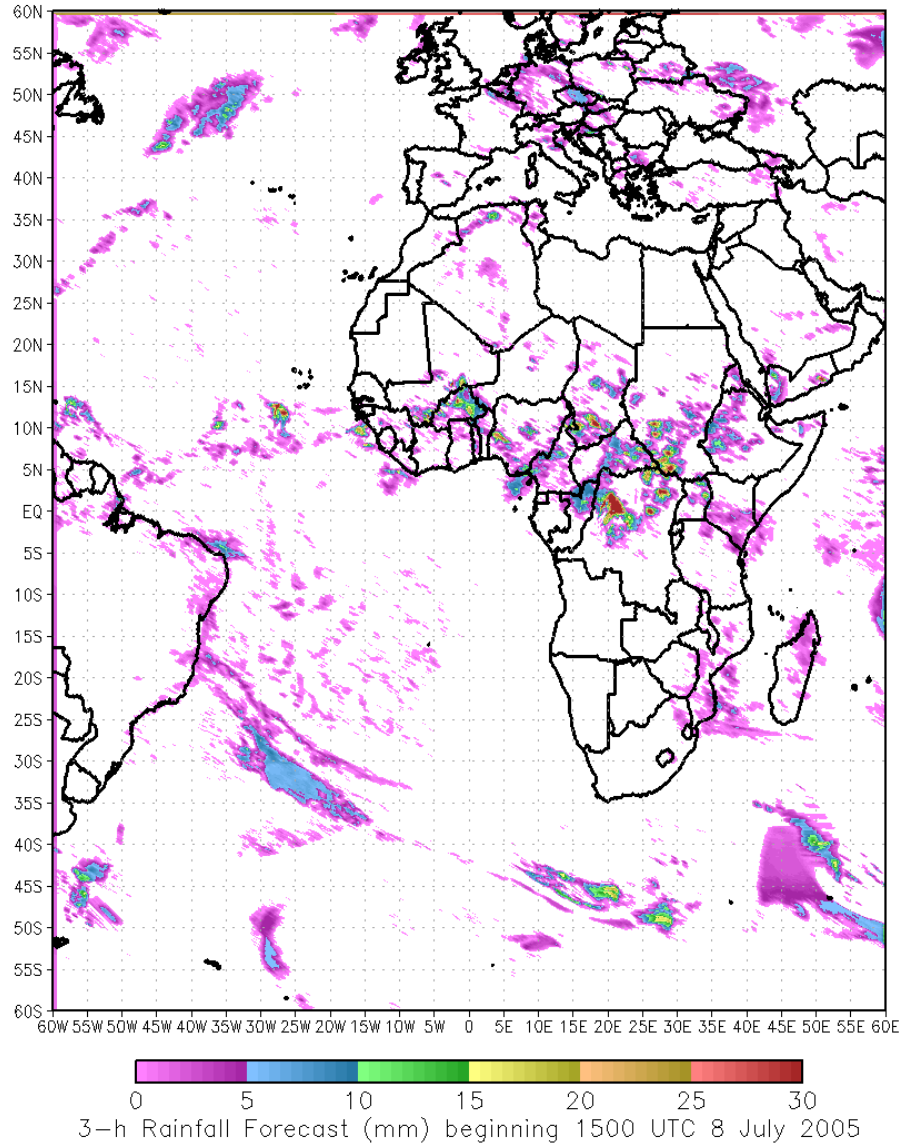
- Predicted rainfall accumulation for the next 3 hours at the satellite pixel scale

- Extrapolation from current and previous rainfall rates from the GOES-R Rainfall Rate Algorithm

Rainfall Potential Algorithm

Courtesy Bob Kuligowski (NESDIS/STAR)

Rainfall Potential from 1500-1800 UTC 8 July 2005 derived from Rainfall Rate fields (retrieved from SEVIRI data) at 1445 and 1500 UTC



Rainfall Probability Algorithm

(Kuligowski)

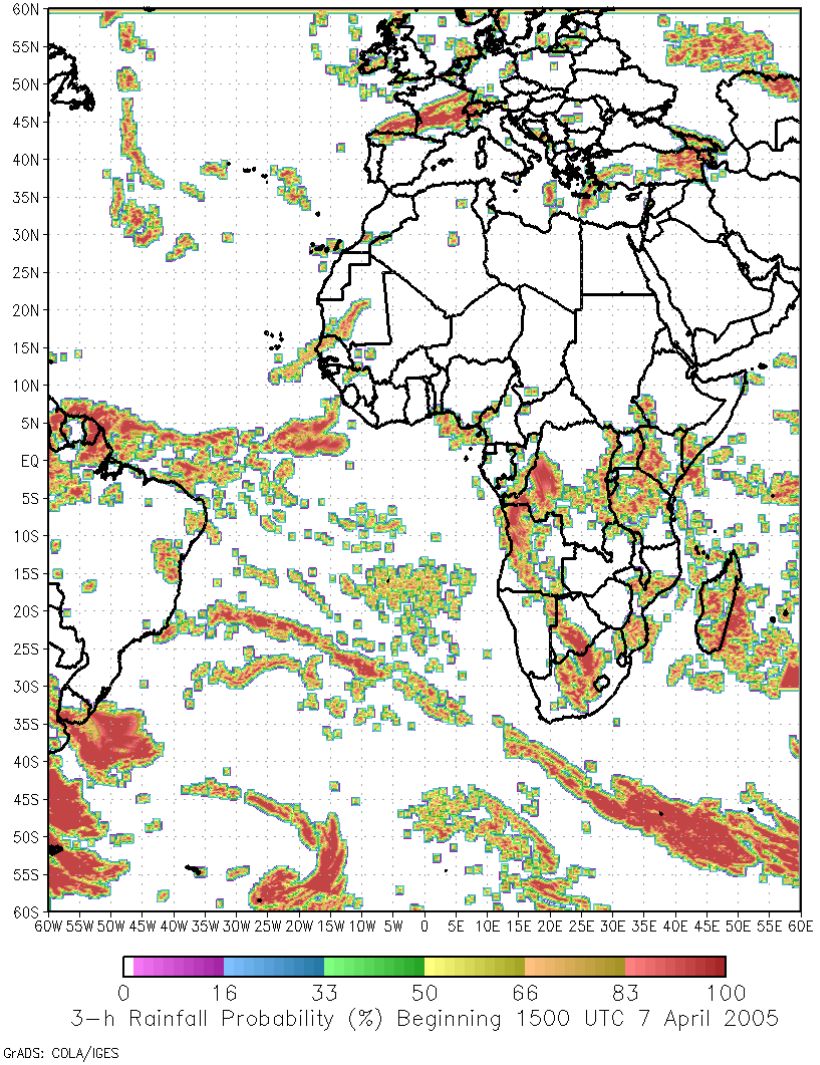
- Probability of rainfall > 1mm for the next 3 hours at the satellite pixel scale. Other, higher levels, have been suggested.

- Based on output and intermediate products from the Rainfall Potential Algorithm

Rainfall Probability Algorithm

Courtesy Bob Kuligowski (NESDIS/STAR)

Probability of Rainfall from 1500-1800 UTC 8 July 2005 derived from intermediate output of Rainfall Potential algorithm (which in turn uses SEVIRI-derived Rainfall Rate fields from 1445 and 1500 UTC as input



Summary

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